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Aids to plaster bandage technique

Corrective plaster jackets for the treatment of scoliosis

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Introduction

The use of plaster jackets for the external stabilisation of the spine in disease or after injury or operation is well known. In the corrective treatment of structural scoliosis the plaster jacket should not only produce straightening and support of the spine but should also correct the scoliotic deformity.

The principles and technique of corrective plaster jacket bandaging were demonstrated as early as the beginning of this century by Wullstein (1902) and Abbott (1911). They used specially constructed frames for the extension of the patients with simultaneous correction by movable pads or bells applied laterally to the trunk. The patients were held in the corrected position until the applied plaster had set. Their methods have been modified and perfected by Hibbs, Risser and Ferguson (1931), Risser (1952, 1958), von Lackum (1948), Moe (1958), Goldstein (1959), Stagnara (1958) and Cotrel (1964). Cotrel is particularly to be thanked for essential simplifications and improvements of technical detail.

The principles of correction are based on consideration of the incorrect position of the scoliotic spine, as the result of the lateral displacement of one or more sections of the spine, the rotation of the vertebrae in the curvatures, and differing individual deviations from the physiological thoracic kyphosis and lumbar lordosis. A three-dimensional deformity of the spine occurs. Characteristically there are structural distortion of the vertebrae and wedge-deformation of the inter-vertebral discs. These structural changes are more marked in the main curvatures than in the functional or compensatory curvatures which arise cranially and caudally to maintain the static balance of the spine.

Within each structurally fixed (main) curvature the vertebra lying at the curvature apex shows the most marked lateral displacement from the long axis of the trunk and the most rotation and distortion. The vertebrae at the caudal and cranial ends of the curvature are usually not rotated, and show little deformation, but they are the vertebrae most tilted from the horizontal plane.

All measures for the passive correction of the curvature must concentrate on its type and position, since these determine the progression of the scoliosis. Measures must attempt to correct the lateral displacement of the spine and of the apical vertebra, and thereby also reduce the pathological rotation. This is effected by the combination of extension of the spine on its long axis from head to pelvis with lateral pressure applied to the apex of the curvature – the classical **three-point-correction** principle. According to Cobb, for the straightening of slight and medium curvatures of curvature angles up to 70°, laterally applied pressure is more effective in correction than extension at the end points of the curvature (Illus. 1).

With the lateral pressure against the convexities of the curvatures, correction of the scoliotic deformities and of the rib and loin bulges ensues simultaneously. The pressure applied must be chosen carefully and applied **over a wide surface** to avoid pressure necrosis of the skin. Safer than the "localiser" used by Risser are the lateral and derotation tractions used by Cotrel which, applied to surfaces rather than to points, fit the trunk contour better than stiff correction pads. Windowing of the plaster at the concavities of the curvatures gives room for breathing and symmetrical development of the thorax and reduces the weight of the plaster.

Correction of the spinal curvature and the trunk deformity can be attained by continuous or staged correction. We distinguish, accordingly, between **staged** and **continuous pressure plaster bandaging.** In staged plaster bandaging a trunk correction is held after its attainment by special positioning, extension and correction of the patient. Full correction is attained in stages by several consecutive plasters. Examples are the "Localiser Cast" of Risser (1958), the "Extension-derotation-flexion (EDF) plaster" of Cotrel (1964) and the "Surcingle Cast" of Von Lackum (1948), little known to us. These plasters have proved themselves of value in the fields of conservative or operative treatment of scoliosis.

The use of continuous pressure plaster bandaging for continuous correction of severe scoliosis has diminished in recent years. The "Turnbuckle Cast" (Curvature continuous pressure plaster) of Risser (1953) and the extension continuous pressure plaster, "Extensions-Quengelgips" of Stagnara (1956) have been largely replaced by various forms of halo-extension which produce effective longitudinal extension of the spine and interfere less with physiotherapy than the trunk plasters. Their preparation and the technical details concerned are therefore only briefly described.

For the construction of staged plasters today we use both Cotrel's and Risser's plaster frames, whereby additional building permits, even in the Risser plaster, the application of Cotrel's derotation straps for lateral correction. By the use of plaster slabs, these plaster techniques have become very similar. For the EDF plaster bandage, the collar typical of the Risser plaster is absent.

We use the EDF plaster readily for pre-operative correction or prevention of further progression of deformity which cannot immediately be provided by a Milwaukee Corset. Since the patient is supported only at the neck and the pelvis under application in extension, the plaster may be well modelled to the trunk. Cotrel uses it routinely also for post-operative stabilisation.

After corrective operations and stabilisation of the spine by ventral or dorsal fusion, however, we prefer the Risser frame for the application of the plaster jacket as the patient is supported at the pelvis, shoulders and head. The additional support at the shoulders appears more secure to us, while also permitting the functionally necessary collar.

Independent of which frame is used for the application of the plaster, the following principles serve for our technique:

- the plaster should be applied as a single cast, with the trunk padded as little as possible;
- in general, two layers of special knitted vest material is sufficient padding, the outer layer adhering to the plaster and the inner layer being changeable under the plaster cast;
- the pelvic crests, sacrum and scapulae are padded, in thin patients only, with a thin layer of foam material; padding of the pelvic and shoulder girdles is usually necessary only in the extension pin plaster and the turnbuckle plaster;
- the patient is held in extension from head to pelvis and the trunk straightened in statically compensated position of the spine;
- the pressure applied laterally to the apex of the curvature is achieved with corrective linen straps of various widths, applied to the plaster cast while it is still moist and drawn to traction before the plaster sets;
- a rapidly applied plaster jacket with fault-free inner surface is thereby to be produced, predominantly by the use of plaster slabs.

1 Postoperative correction plaster, after Rissel and Cotrel

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1. Plaster frame

The rectangular frame constructed by Risser (Illus. 2) is made up of two bridges. This has been supplemented by us with a moveable and tiltable pelvic support and a frame extension, on which Cotrel's lateral corrective derotation straps can be applied and stretched. The so-called "localiser" is no longer used for the correction of the rib bulge, but serves as a highly adjustable head support. Across the frame is the support for the shoulder girdle to which the long strap is stretched (Illus. 3). This long strap is tensed by a ratchet at the foot end of the frame (Illus. 4) and supports the patient while he is held until then by head and pelvis extension only. For the fixing of the head extension and the pelvic straps, moveable spindles are mounted on the cross-pieces (Illus. 5).

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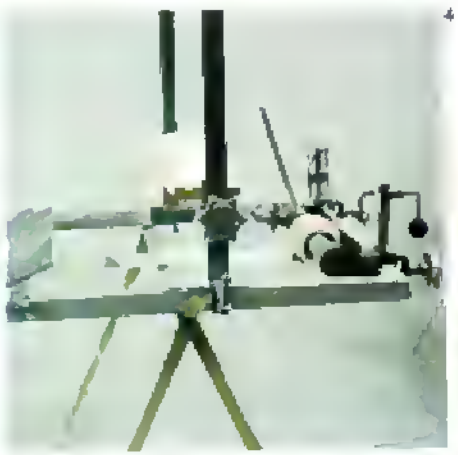

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2. Preparation and positioning of the patient

The post-operative plaster jacket is applied about 10 to 14 days after the fusion operation. Light sedation is recommended for children and young persons. The patient is first taken out of the back shell with thigh extensions (Illus. 6). After removal of skin stitches and cleaning of the skin, two cross-elastic knitted shirts are put on, these being available in three sizes. The outer layer adheres to the plaster, while the inner layer makes an undergarment which can later be changed under the plaster (Illus. 7).

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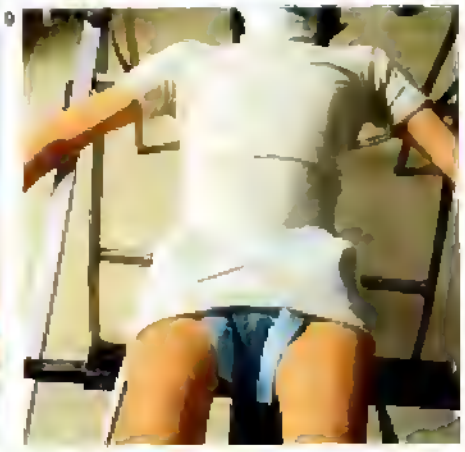

After the patient is laid on the Risser frame the head and pelvis supports are adjusted and the head extension and pelvis strap applied. For the extension of the head a simple padded sling is used, which holds the head under the chin and under the occiput (Illus. 8). Two extension straps, right and left loops, are applied around the pelvis. Each loop passes above the iliac crest on one side obliquely to its traction ring below the greater trochanter, and on the lateral side of the thigh on the other side, the loops thus cross anteriorly above the symphysis pubis (Illus. 9). These traction loops designed by Cotrel are made of bands with a ring at the end, through which the free end is passed to make the loop. The ring is thus adjustable to the height of the greater trochanter (Illus. 10). These loops hold the pelvis which can now be positioned as required, by symmetrical or asymmetrical traction. By asymmetrical oblique traction a pelvic deformity is corrected; by asymmetrical positioning of the rings, pelvic rotation is corrected.

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If the patients's waist is asymmetrical, as in all cases of lumbar scoliosis, the traction loop should be applied directly on the iliac crest on the side of the concavity, and above the iliac crest, drawing the waist in, on the side of the convexity of the lumbar curvature (Illus. 11)
This traction is increased by traction on the extension straps and an approximately symmetrical waist outline is obtained (Illus. 12).

The straps pass between the two underclothing layers and thus they do not adhere to the plaster, and can be removed when the plaster has set. Horizontal straightening of the pelvis is essential; neither pelvic deformity nor pelvic rotation should be produced by the plaster! The tilt of the pelvis and degree of lumbar lordosis is determined by the positioning of the legs The more the legs are flexed at the hip joints the more is the pelvis raised and the lumbar spine made less lordotic. The patient's legs are supported at the knees by padded knee supports.


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With cautiously increased traction of the head and pelvis the position of the patient is increasingly stabilised. The force of head traction is controlled by a spring balance: it should not exceed 20 to 25% of the body weight. This traction does not cause further correction of the scoliosis, but facilitates the stabilisation of the patient under perpendicular straightening of the spine over the pelvis. After the patient's immobilisation the long strap is superfluous and can be removed

The outer net shirt below is drawn over the iliac crests. The shirt collars are drawn up, anteriorly over the chin to the mouth and posteriorly to the occiput, the soft tissue of the neck being padded with a felt neck collar (Illus. 13). This neck collar is cut from felt of 5 to 6 mm thickness, and shaped as shown (Illus. 14). In thin patients the anterior iliac spines are padded with self adhering foam material (Illus. 15), and usually the scapular spines also (Illus. 16). After the checking of the vertical straightening of the trunk above the pelvis and the positioning of the shoulder girdle and the pelvis (Illus. 17) the plaster can be applied.

Note:

- **crease-free application of the net shirts**
- **exact straightening of the pelvis in all planes**
- **no induction of kyphosis of the lumbar spine**
- **asymmetrical positioning of the pelvic extension straps in lumbar scoliosis**
- **perpendicular straightening of the spine between the shoulder girdle and the pelvis**
- **straightening of the head in mid-position**

3. Application of the plaster bandage

Plaster bandages used:
One 15–20 cm wide 8-layered Cellona slab (pelvis),
two 15–20 cm wide 4-layered Cellona slabs (trunk)
two 12–15 cm wide 4-layered Cellona slabs (shoulder)
one 8–10 cm wide 4-layered Cellona slab (neck)
one 20 cm wide 4-layered Cellona slab (back)
two 15–20 cm wide Cellona plaster bandages
two 10–12 cm wide Cellona plaster bandages

The slabs are cut before the application of the plaster, according to the trunk measurements.

At least three persons are needed for the application of the plaster, one person standing on the patient's right, one on the left, and one to pass the wettened slabs. The 15 to 20 cm wide eight-layer slab is so applied around the pelvis (illus. 18, 19, 20) that the ends overlap obliquely above the symphysis pubis and the plaster extends well up to the waist. Moving cranially, the two 15 to 20 cm wide slabs are laid, in turn, around the trunk (illus. 21, 22), lightly drawn in, and modelled to the thorax and the back (illus. 23). Then follow the two 10 to 12 cm wide slabs which proceed from the front to the back of the thorax over the shoulders (illus. 24). These must be well modelled in the regions of the shoulders, neck and scapulae (illus. 25).


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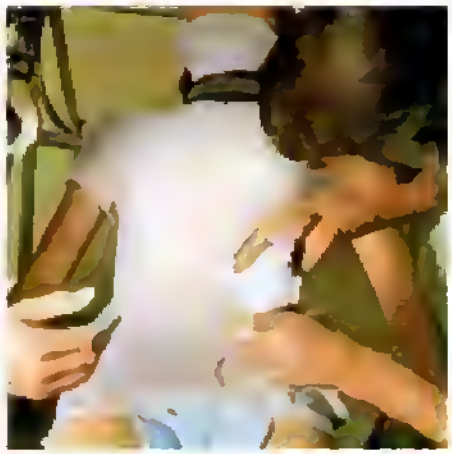
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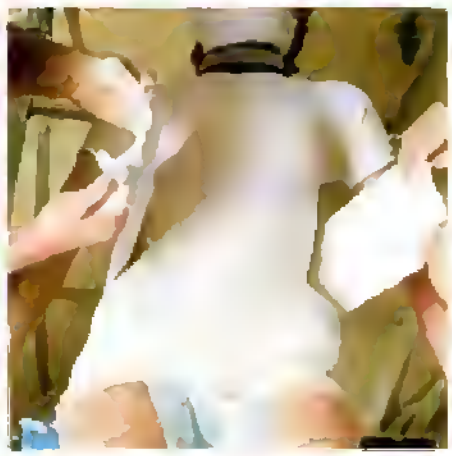
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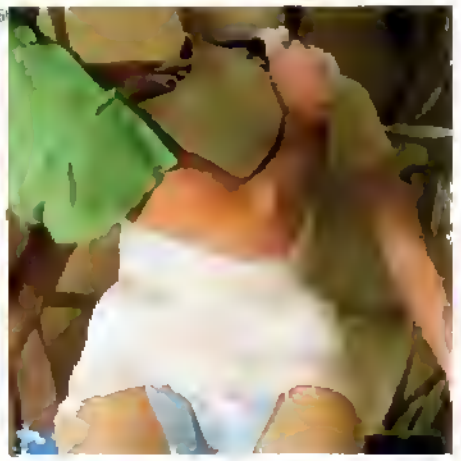

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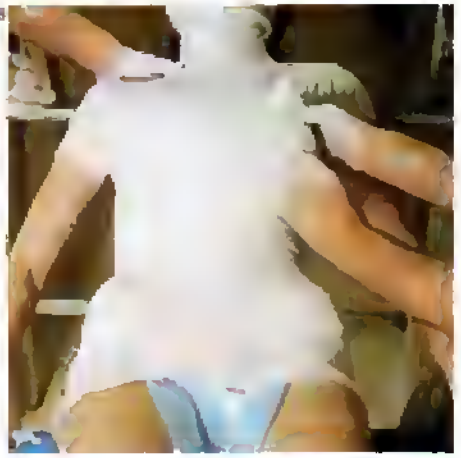

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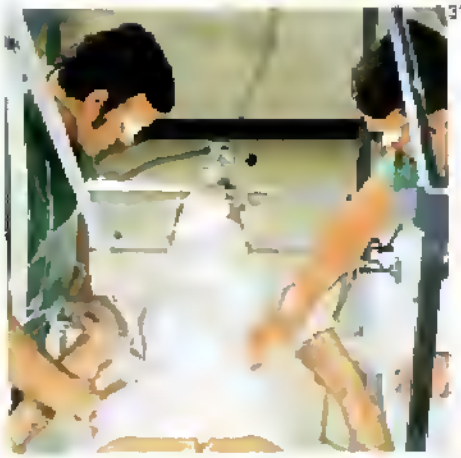
An 9 to 10 cm wide four-layer slab, applied circularly around the neck, forms the plaster collar (Illus. 26, 27). At the back of this the plaster is strengthened with a 20 cm wide four-layer slab which must reach from the level of the iliac crests to the occiput. This is well modelled at the occiput, so that the head support subsequently will be at the occiput and not at the chin. The patient will push against this later under isometric tension of the back muscles.

The slabs applied to the trunk overlap circularly and vertically. They are additionally secured with circular plaster bandages (Illus. 28).

In the modelling of the plaster bandages it must be ensured that the waist above the pelvic brim is well held in order to ease the pressure on the iliac crests and avoid the risk of pressure sites over the iliac spines. The plastering of the convex side of the asymmetrical waist is particularly to be stressed. Furthermore the plaster must fit the trunk closely dorsally on the convex side and ventrally on the concave side, since here ensues later the best wide-surfaced correction of the scoliotic trunk deformity.

For lateral correction and derotation the correction straps are applied over the still wet plaster. They are attached laterally to the frame and proceed around the trunk of the patient dorsally and thereafter obliquely upwards to the upper bar of the frame. Here they are fastened in special clamps (Illus. 29) and made taut by rotation of the long bars (Illus. 30).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In a single thoracic scoliosis we use a strap which passes horizontally from the concave side of the thorax over the rib bulge to the axilla of the convex side and thence obliquely upwards to the upper bar of the frame (Illus. 31). The strap must proceed such that dorso-medial correction of the rib bulge ensues. Against the traction of the correction strap follows a light counter pressure at the shoulder and pelvis on the convex side of the thoracic curvature.


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While in single thoracic or thoracolumbar scoliosis a correction strap is used, in double bowed thoracic and lumbar scolioses two contra-acting straps are necessary. The correction strap for the lumbar curvature is less wide than that for the thoracic curvature (Illus. 32). It corrects on the convex side, drawing in the waist on that side and restoring the symmetry of the trunk.


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The thoracic correction strap must proceed such that correction of the rib bulge ensues dorso-medially. Lateral pressure against the thoracic flank on the convex side is to be avoided (Illus. 33, 34) since it would worsen the rib bulge. The ribs could not move laterally and forwards from the dorsal pressure. Furthermore it must be seen that the correction strap holds at least the lower third of the scapula on the convex side (Illus. 35), otherwise pressure points can develop at the lower scapular angle.

Note:

- **firm application and modelling of the plaster slabs**
- **exact modelling of the plaster collar and the back slab up to the occiput**
- **creaseless application of the correction straps**
- **no pressure on the thoracic flank on the convex side**

4. Cutting out the plaster bandage

In order to stabilise the trunk exactly, the pelvis, flanks and shoulder girdle must be well held. The head obtains its support at the occiput, not at the jaw or floor of the mouth. The respiratory movements of the diaphragm and the dorsal thoracic cage wall on the concave side should be as unhindered as possible. The plaster bandage is trimmed appropriately when it has set.

The plaster is cut away (Illus. 36) in curves front and back at the shoulder so that the arms are sufficiently free to move at the shoulder-joints. The axillae must be free for body hygiene.

The plaster collar is cut in U-shape (Illus. 37) anteriorly with removal of the plaster padding so that the floor of the mouth and the larynx are free. The plaster edges under the lower jaws are carefully rounded off (Illus. 38 and 39).

The sleeves of the outer knitted shirt are shortened (Illus. 40), everted over the plaster edges and fixed with plaster strips (Illus. 41).

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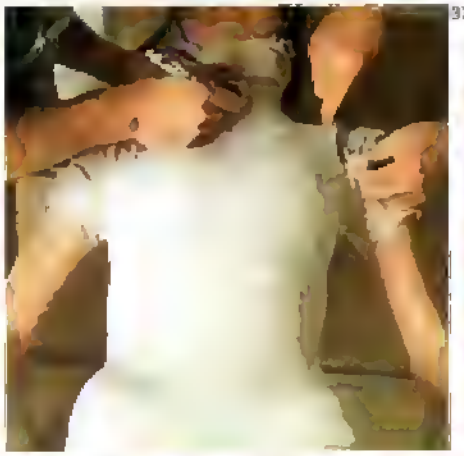

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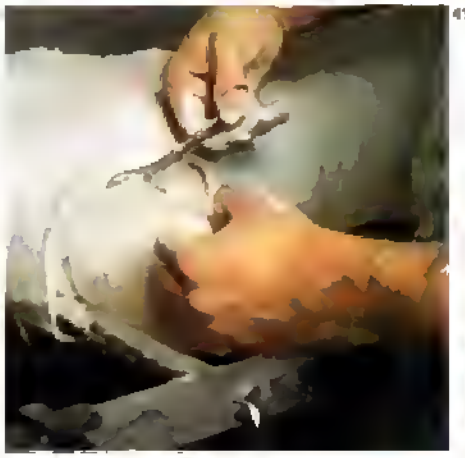

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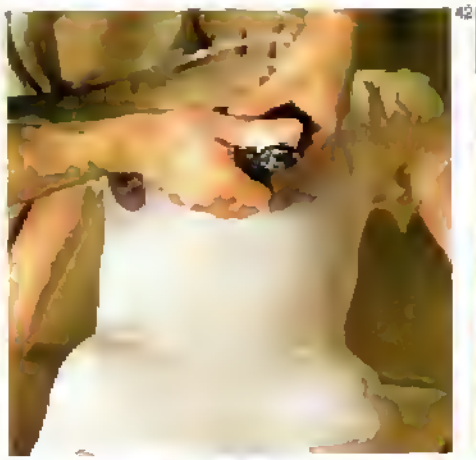
Over the thoracic cage and upper abdomen a shield-like window is cut in the plaster with a plaster saw (Illus. 42). With the blunt end of a cobbler's knife the edge is underprised carefully, raised up as a flap and finally removed from the plaster jacket in one piece (Illus. 43 and 44).

For the correction of an asymmetrical anterior rib curvature (anterior rib hump) the anterior window can be cut out asymmetrically (Illus. 46).

The outer shirt layer is slightly raised and then incised (Illus. 45). The free edges of the shirt are everted over the edge of the plaster window and fixed in place with plaster strips (Illus. 46 and 47).

The lower edge of the plaster is so trimmed in anterior deflection that the legs can be flexed to 90° at the hip (Illus. 49). The patient must be able to sit freely without the plaster bandage being thereby shifted headwards.

After the loosening of the head and pelvis extension and the shoulder support, the patient can be taken from the plaster frame and the plaster bandage completed. The pelvic extension belts under the plaster and between the two knitted shirt layers are drawn out (Illus. 50). The patient is now set upright in the plaster for a short time in order to test whether the plaster is adequately trimmed anteriorly above the thigh. The underedge of the back side is smoothly trimmed.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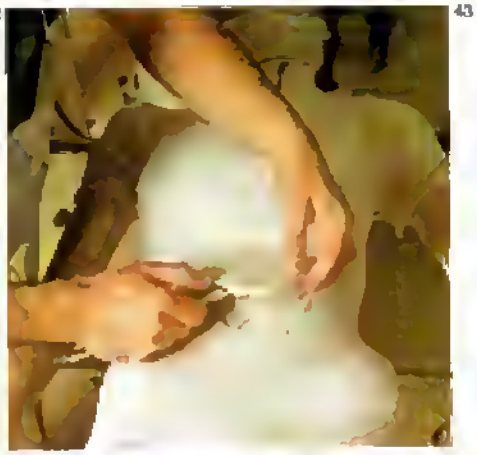
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The plaster should end about four finger's breadth above the sitting plane (Illus. 51). Here also the outer knitted shirt layer is cut near the plaster edge, reflected over it and secured with strips of plaster. Thereby smooth edges are obtained on all sides.

24 hours after the application of the plaster a wing-shaped window is cut from the plaster on the dorsal convex side in the thoracic region (Illus. 52 and 53), by which the development of the concave side thoracic flank is facilitated. By this window no damage is done to the stability or supportive function of the plaster (Illus. 54).


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According to the size of the patient the post-operative trunk plaster jacket, after Risser and Cotrel, has a weight of 1.5 to 3 kg. This relatively small weight facilitates the rehabilitation of the patient. The plaster can only be kept so light, yet meeting requirements, if its support zones are wide-surfaced and if it is applied closely to the trunk (Illus. 56 and 57) and if the inner surface remains crease-free (Illus. 55).


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Support zones:

- Occiput
- Convex side dorsal thorax flank
- Waist
- Symphysis pubis

5. Mobilisation of the patient

24 hours after application the plaster is sufficiently dry and firm for the patient to be mobilised. Sitting on the edge of the bed follows medical gymnastics in a supported side position. Thereafter follow standing out of bed, walking and walking up steps. In a few days the patient is again able to look after himself. Our young patients participate again in school studies 4 weeks after posterior spinal fusion.

The closely applied plaster jacket is cosmetically of an acceptable appearance (Illus. 58), and normal clothing can be worn over it (Illus. 59).

To facilitate personal body care the undershirt can be removed for washing. This change of underclothing is facilitated by the cross-elastic weave of the material. In putting it on under the plaster the shirt should first be drawn over the head (Illus. 60) and then drawn under the shoulder frame through to the left shoulder (Illus. 61). The left arm is then put into the sleeve (Illus. 62) and the shirt then drawn under the right shoulder frame through to the right shoulder. The right sleeve is then drawn over the right arm (Illus. 63), the shirt pushed down to the abdominal and back windows (Illus. 64 and 65) and from there with the help of a rod (flexible knitting needle) to the right or left groin. From there the hem of the shirt can be grasped under the plaster edge and pulled down (Illus. 66).


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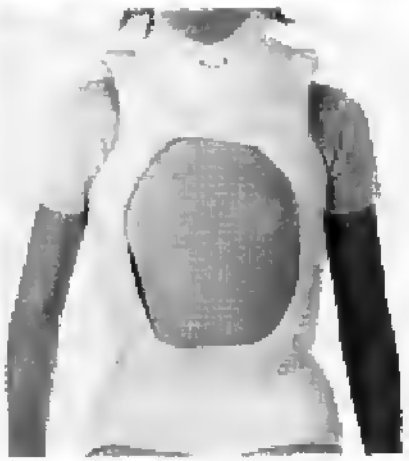

6. Pressure areas

The plaster jacket is examined daily by the patient and every 4 to 6 weeks by the doctor. Pressure areas occur easily in thin patients with poorly developed fat tissue over the posterior iliac spines, the sacrum and the lower angles of the scapulae. The best prophylaxis is frequent changes of position (standing–sitting–lying).

If early mobilisation is not possible, frequent changes of lying position are recommended. Thereby tilting of 20° to the right or left from the supine position can alter the areas subjected to pressure and thus effectively prevent pressure sores. The patient should lie as little as possible on the side of the thorax which corresponds to the convexity of the thoracic curvature.

If pain occurs under the plaster this must be cut away in window form. The plaster is incised in cruciate form over the pressure area with a plaster saw and the angles bent up with a raven's-bill hook. The area may be windowed and then replastered after examination and repadding.

2 The Turn-buckle plaster cast, after Risser, and the extension-pin plaster, after Stagnara

The use of continuous pressure plasters for continuous correction in the post-operative phase or between two spinal operations has become infrequent since the introduction of the helo extension in its various forms (halo-femoral or halo-pelvic traction, halo-brace or halo-gravity extension). In severe scoliosis and kyphosis, traction forces are as effective as corrective pressure forces for the straightening of the spine and stretching of the trunk. The risk of local disorders of blood flow in the skin and of subsequent pressure necrosis is great in all continuous pressure plaster bandaging

Therefore essentially must the support zones and all pressure-endangered areas at the pelvic and shoulder girdles be padded (Illus. 67). For this we use foam meterial of 5 mm thickness. Padding of the neck and throat ensues, with felt. The padding of the angle of the jaw and the under-jaw must be done with particular care as the skin is particularly at risk of pressure here, as these are support points for the plaster.

In Risser's turn-buckle plaster jecket the patient is largely confined to bed. Supplementary treatment by medical gymnastics is hindered (breathing exercises and exercises for muscular strength). This physical inactivity weakens the cardio-vascular and muscular strengths of the patient. These are serious disadvantages for the patient. Even with carelul attention, pressure injuries to the skin are not always evoidable

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Risser's turn-buckle plaster cast is now almost only of historical interest. Risser abandoned it in 1958 in favour of the localiser cast. We use it occasionally for stabilisation and continuous correction after mobilising osteotomies of the spine. For exact stabilisation of the pelvis in relation to the spine it is necessary to include a thigh in the plaster (Illus. 68). For correction of scolioses the thigh on the convex side should be selected, i. e. the side to which the spinal curvature is bowed.

24 hours later, the plaster cast is divided circumferentially at the height of the apex of the curvature and one or two hinges inserted on the convex side and an extension pin on the concave side. By screwing open the extension pin against the counter-resistance of the hinge, correction and extension of the curvature are induced. The correction of the spinal deformity obtained can then be fixed by posterior spinal fusion through a dorsal window cut in the plaster cast.

In Stagnara's extension-pin plaster a continuous traction of the spine is obtained between the head and the pelvis (Illus. 69). Careful padding of the points of support at the lateral points of the jaw and jaw angles, and exact moulding of the plaster to the occiput, are essential. The floor of the mouth and the larynx should be free.

The plaster cast is filled with two extension pins anteriorly and two posteriorly. After setting, the cast is divided circumferentially at the level of the apex of the curvature. Thus, by symmetrical or asymmetrical extension of the pins, individually adjusted correction and traction of the spinal curvature can be induced. The method is effective in thoracolumbar and lumbar scolioses, and in thoracic curvatures with relatively high-placed curvature apices (Illus. 70, 71).

The extension pins can be made relatively easily from extension screws (Illus. 72). Both ends of the extension pins are heated, opened out and riveted to aluminium strips each 10 cm long and 2 cm wide, curved in a semicircle. These can be bent to conform to the shape of the plaster cast and then fixed to it with several turns of plaster bandage.

The hinges are cut from pliable aluminium sheet.


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Note:

- **Adequate padding of the shoulder girdle, rib borders and pelvis**
- **Careful moulding of the plaster bandage at the support zones**
- **Daily checking of the support zones at the angle of the jaw and mandible**
- **Regular movement of the patient to avoid unilateral pressure and ischaemic skin lesions**

3 Cotrel's Extension-Derotation-Flexion Plaster

1. The plaster frame

Cotrel constructed a mobile frame (Illus. 73) the long supports of which are rotatable outwards about their axes and carry locking devices for the correction straps. These long supports (designated A1 and A2, B1 and B2, C1, C2 and C3 in the diagrams) are arranged at three heights. The middle long supports are connected to each other by two slim metal bands by which the patient is supported at pelvis and neck. The lower long supports hold the plaster catcher. On the upper long supports, two outside handgrips, adjustable vertically and horizontally, are fitted. The upper middle long support carries the hanging sling for the legs. To the side supports pulleys are fitted at the head and foot ends, in which the traction straps for head and pelvis traction can be stretched. The head traction is adjustable vertically and laterally, permitting individual adjustment of head traction.

In the middle of the frame, parallel to the middle long supports, a 16 cm wide strap is stretched, on which the patient is laid for application of head and pelvis extension plasters.

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2. Positioning and extension of the patient

After putting on two cross-elastic knitted shirts the patient is laid on the stretched carrying strap. The patient's head and neck are supported on the second adjustable unpadded metal band (Illus. 74). The patient's legs are supported below the knee in the hanging sling, the height of which is adjustable. By the positioning of the degree of extension of the legs at the knees the position of the pelvis can be influenced: the higher the legs are raised, the more is the pelvis tilted and thus the lumber spine made less lordotic.

The pelvis is fixed and straightened with the pelvis straps (Illus. 75). The correct positioning of the pelvis is an essential prerequisite for straightening the spine. For the application of the pelvis straps the principle is the same as that described for the Risser-Cotrel trunk plaster.

The patient's head is held by a simple sling with loops under the chin and the occiput. A spring balance is interposed in the head traction strap for control of head traction (Illus. 76).

In addition to correct positioning of the pelvis, Cotrel attached great value to the horizontal straightening of the shoulder girdle. A unilateral shoulder drop, which is found on the convex side of every single-bowed thoracic scoliosis, is to be corrected, according to Cotrel, by asymmetrical positioning of the arm and pressure with the shoulder girdle. For this the arm on the convex side is laid on the middle long support (Illus. 76) in the plane of the body and, by elevation of the arm on the concave side, by the hand grip, the back rotation of the shoulder on the convex side is supported.

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The arm on the convex side is abducted at the shoulder by about 60°, the forearm lying horizontally on the long support pole (Illus. 77). The arm on the concave side is abducted at the shoulder by about 60° and raised about 30 to 40° from the horizontal. The patient bends the arm at the elbow at a right angle and grips the hand grip suspended from the upper support pole (Illus. 78).

If there is no asymmetry of the shoulder girdle, or if the shoulders are symmetrical in relation to the trunk, both arms are abducted from the shoulders by 60 to 70° and laid horizontally on the long support poles at the patient's sides.

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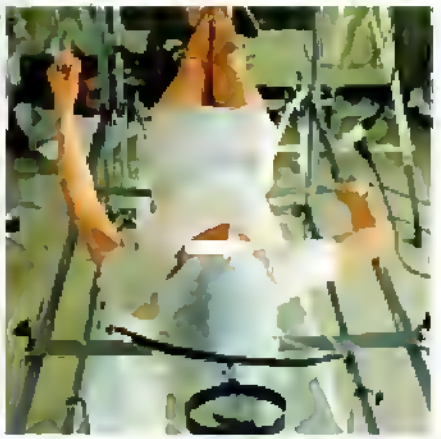

The force of the traction is very variably tolerated. Colrel obtained traction forces corresponding to the body weights of the patients. It should be stated, however, that at this force of traction there is risk to the cervical spine and the cervical plexus. In scolioses of between 40 and 70°, which are essentially the indications for treatment with the EDF plaster, the traction force is of less corrective importance than the lateral force applied at the apex of the curvature. Therefore extension forces between 10 and 20 kp (according to the weight of the patient) are sufficient for stretching the spine and stabilising the trunk on the frame.

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During the extension the patient is asked to breathe deeply. Thereby the trunk musculature is relaxed and the force of traction is distributed uniformly along the spine. Under extension the trunk of the patient is thus stabilised so that support is only necessary at neck/occiput and pelvis. After the straightening of the pelvis and shoulder girdle has been checked again, the outer shirt can be drawn over the pelvis and pelvis traction straps and the plaster bandages applied to the trunk.

3. Application of the plaster bandage

Plasters required
One 15–20 cm wide 8-layered Cellona slab (pelvis);
two 15–20 cm wide 4-layered Cellona slabs (trunk);
two 10–12 cm wide 4-layered Cellona slabs (shoulder);
one 20 cm wide 4-layered Cellona slab (back);
two 15–20 cm wide Cellona plaster bandages;
two 10–12 cm wide Cellona plaster bandages

Three persons should be available for the application of the trunk plaster, if possible. The procedure is as for the making of the post-operative Risser-Cotrel plaster jacket, as already described, but the collar around the neck is omitted. The 15–20 cm wide, 8-layered slab is applied around the pelvis (Illus. 79), during which the plaster is well moulded to the waist above the pelvic brim. The next plasters applied, nearer the head and overlapping, are the 15–20 cm wide, 4-layered slabs (Illus. 80, 81).

The two 10–12 cm wide slabs are applied to the shoulders from front to back (Illus. 82), the 20 cm slab strengthening the back of the plaster. The plaster slabs, moulded exactly to the back and the flanks, are fixed to the trunk with the plaster bandages, with careful moulding over the waist, symphysis pubis, shoulders and contours of the trunk.


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Note:

- **Crease-free positioning ot the knitted shirts**
- **Exact straightening of the pelvis in all planes**
- **Vertical straightening of the spine between the shoulder girdle and the pelvis**
- **For asyemmetrical waists, asymmetrical positioning of the pelvis straps with appropriately asymmetrical traction**
- **Asymmetrical positioning of the shoulder girdle for correction of unilateral shoulder drop**
- **Correct positioning of the head**

Cotrel attempts to influence all the components of scoliotic spinal deformity with the extension-derotation-flexion plaster and to achieve:

- straightening of the lateral bending by traction in the long axis of the body,
- further straightening and additional derotation of the vertebrae in the curvature by correction with correction straps applied at the apex of the curvature,
- unbending and derotation of the structurally fixed spinal curvature by flexion of the trunk against the lateral bending.

The combination of traction with correction applied laterally against the apex of the curvature permits impressive overall correction. The flexion of the trunk against the lateral bending in single-curve scolioses brings, more certainly, a further straightening of the fixed curvature and supports the derotation. It appears to us, however, to be of risk on the following grounds.

The flexion of the trunk reduces the angle of the structural curvature, but strengthens the compensatory curvatures, especially the caudal one in the lumbar region. This increases the asymmetrical loading of the extensor muscles of the back and worsens the spinal posture.
The dark vertical line marked S in the diagram on the trunk shifts widely laterally and outside the mid-pelvis. We note, thus, in the application of the plaster bandage, the need for the application of the plaster to be to as vertically straightened a spinal column as possible in postural compensation over the pelvis.

Moreover, the possibility of correction by flexion only exists in the treatment of single curvature scolioses, and not in double thoraco-lumbar curvatures.

4. Correction strap technique

The correction straps are laid without interruption over the still wet plaster, fixed to the long supports, and stretched as uniformly as possible. Their working principle is tripartite

1. straightening of the lateral bowing by lateral pressure against the apex of the curvature,
2. correction of the rib hump on the convex side, and of the loin bulge;
3. derotation of the rotated spinal segment.

The number and positioning of the correction straps depend on the form and position of the structural curvature. In the common form of single-bowed right-convex thoracic curvature, the correction strap passes from the long support B1 on the concave side (Diagram I and illustrations 83, 84, 85, and 86), across the back of the patient and around the rib hump on the convex side and thence upwards and laterally to the upper long support C3. Thereby, no pressure is exerted on the flank of the thorax on the convex side, and the corrected ribs can shift laterally and ventrally. The shoulder strap (Diagram I) counteracts the derotation of the thoracic correction strap and corrects the position of the shoulder on the convex side which is rotated ventrally. This strap loops from the ventral and dorsal axillary folds on the concave side around the thorax and draws the shoulder on the convex side dorsally by traction over the long support B2 (illus. 87).


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I. Single-bowed right-convex thoracic curvature.

Number of straps:
1 correction strap
1 shoulder strap

Course of the correction strap:
From B1 horizontally over the rib hump, then obliquely upwards and outwards to C3, over C3, and across to C1.

Fixing:
at B1 and C1

Stretching:
rotation of C1

Course of the shoulder strap:
From the back of the scapula of the concave side, in one direction obliquely upwards and across to C3, in the other direction diverging ventrally and dorsally to embrace the thorax and leading to B2, passing over B2 to A2.

Stretching:
rotation of C3 and A2

Note:
The thoracic correction strap and the shoulder strap are stretched simultaneously by rotation of the long supports A2, C1 and C3. No correction pressure is exerted laterally against the thorax flank on the convex side. Positioning of the suture line of the three components of the shoulder strap at the scapula on the concave side must be exact. The shoulder strap must drawn the axilla on the concave side towards the shoulder on the convex side at as cranial a level as possible.

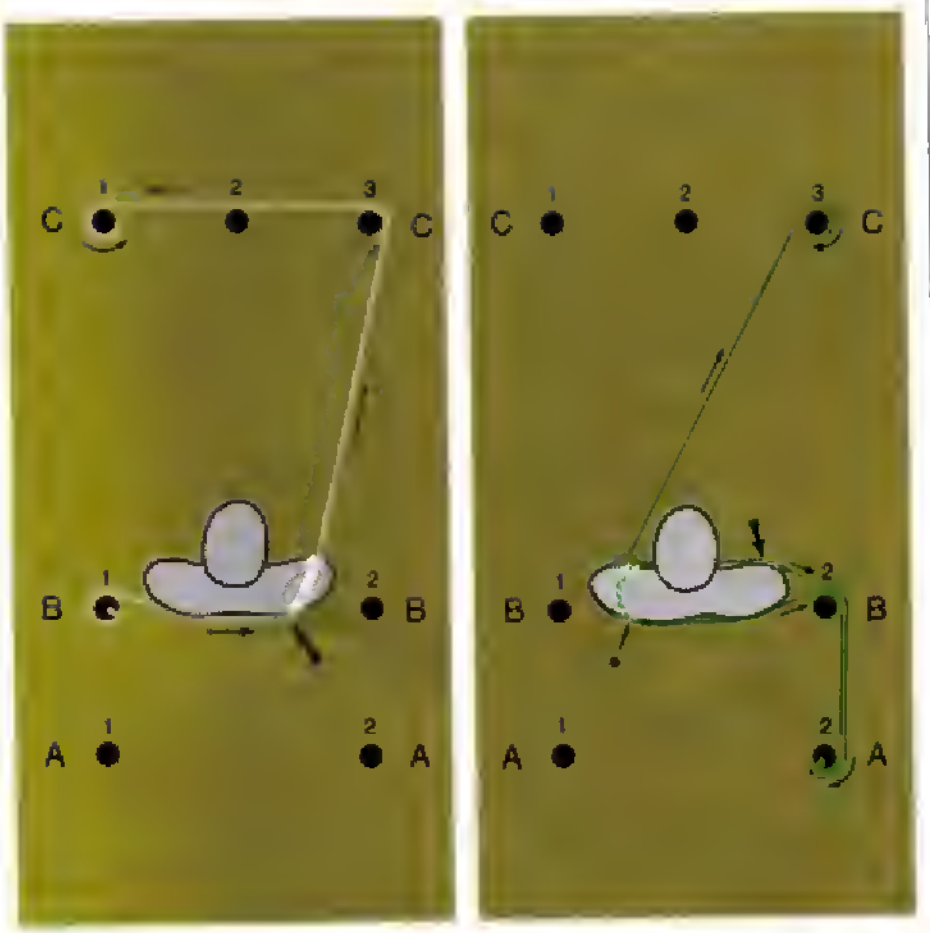

Diagram I: Courses of the correction straps for a single-bowed right-convex. thoracic scoliosis

II. Single-bowed, right-convex, thoraco-lumbar curvature.

Number of straps:
2 correction straps
1 shoulder strap

Course of the correction straps:
1. The **thoracic strap** passes from B1 horizontally behind the patient and around the rib hump, then laterally and upwards to C3, around C3 and across to C1.
2. The **lumbar strap** starts at A1, passes over B1 and then around the back and convex side of the trunk, overlapping the thoracic strap and then to C3 and C1.

Fixing:
of the thoracic strap, at B1 and C1;
of the lumbar strap, at A1 and C1.

Stretching:
rotation of C1 and, if necessary, of A1.

Course of the shoulder strap:
From the back of the scapula of the concave side, in one direction obliquely upwards and across to C3, in the other direction diverging ventrally and dorsally to embrace the thorax and leading to B2, passing over B2 to A2

Note:
The thoracic correction strap and the shoulder strap are stretched simultaneously by rotation of the long supports A2, C1 and C3. No correction pressure is exerted laterally against the thorax flank on the convex side. Positioning of the suture line of the three components of the shoulder strap at the scapula on the concave side must be exact. The shoulder strap must draw the axilla on the concave side towards the shoulder on the convex side at as cranial a level as possible.

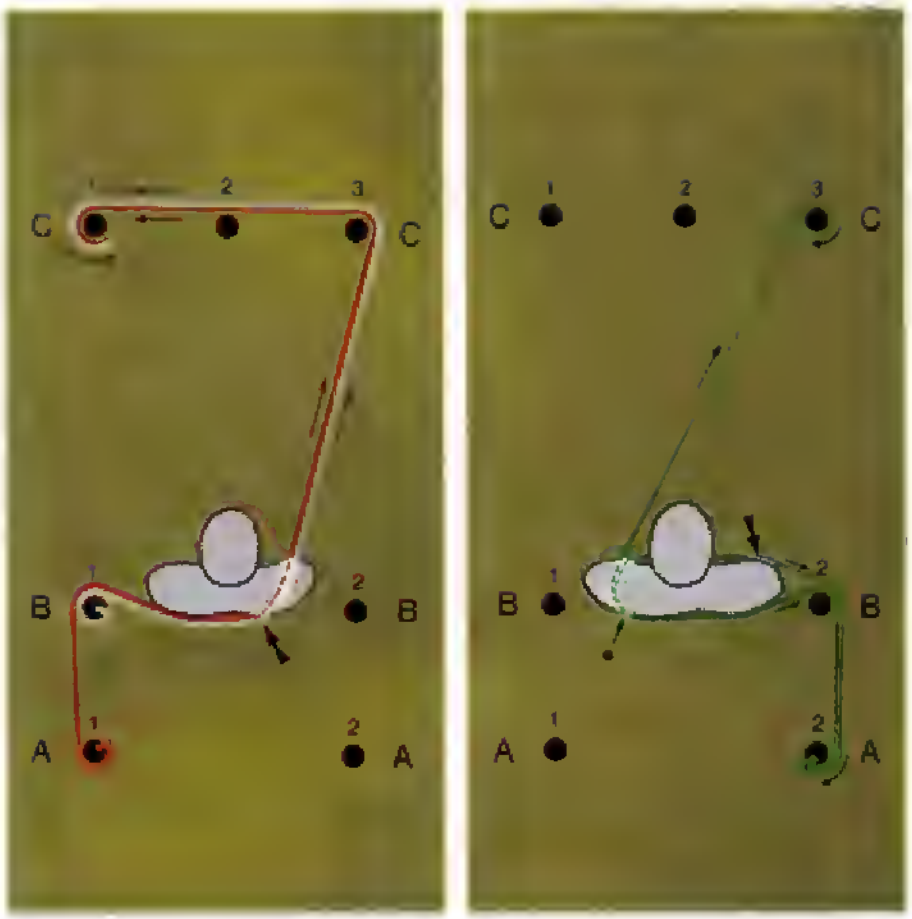

Diagram II: Courses of the correction straps for a single-bowed, right-convex, thoracolumbar scoliosis

In the right-convex, thoracolumbar curvature two parallel-proceeding, overlapping correction bandages are used. Therein the cranially lying strap is applied as for a single-bowed thoracic scoliosis, while the lower strap encloses the rib hump and loin bulge and is led around the waist (Diagram II). It thus assists in the deepening of the plastered waist on the convex side.

In all single-bowed and thoraco-lumbar scolioses the shoulder strap is obligatory as a counter-correction. It secures the parallel alignment of the shoulder girdle to the pelvis and corrects the ventrally rotated shoulder on the convex side. In addition, with this strap, an existing trunk projection may be very well adjusted

III. Single-bowed, predominantly left-convex lumbar curvature.

Number of straps:
2 correction straps.

Course of correction straps:
1. The **lumber strap** passes from B2 horizontally behind the patient and over the loin bulge, and then vertically upwards over C2 to C3.
2. The **thoracic strap,** for counter-traction, passes from B1 horizontally in the line of the ribs to the right thorax flank and thence obliquely upwards over C3 to C1

Fixing:
of the lumbar strap, at B2 and C3;
of the thoracic strap, at B1 and C1

Stretching:
rotation of C1 and C3

Note:
Crease-free application of the correction straps and uniform stretching of the thoracic and lumbar straps. No correction pressure laterally against the thorax flank.

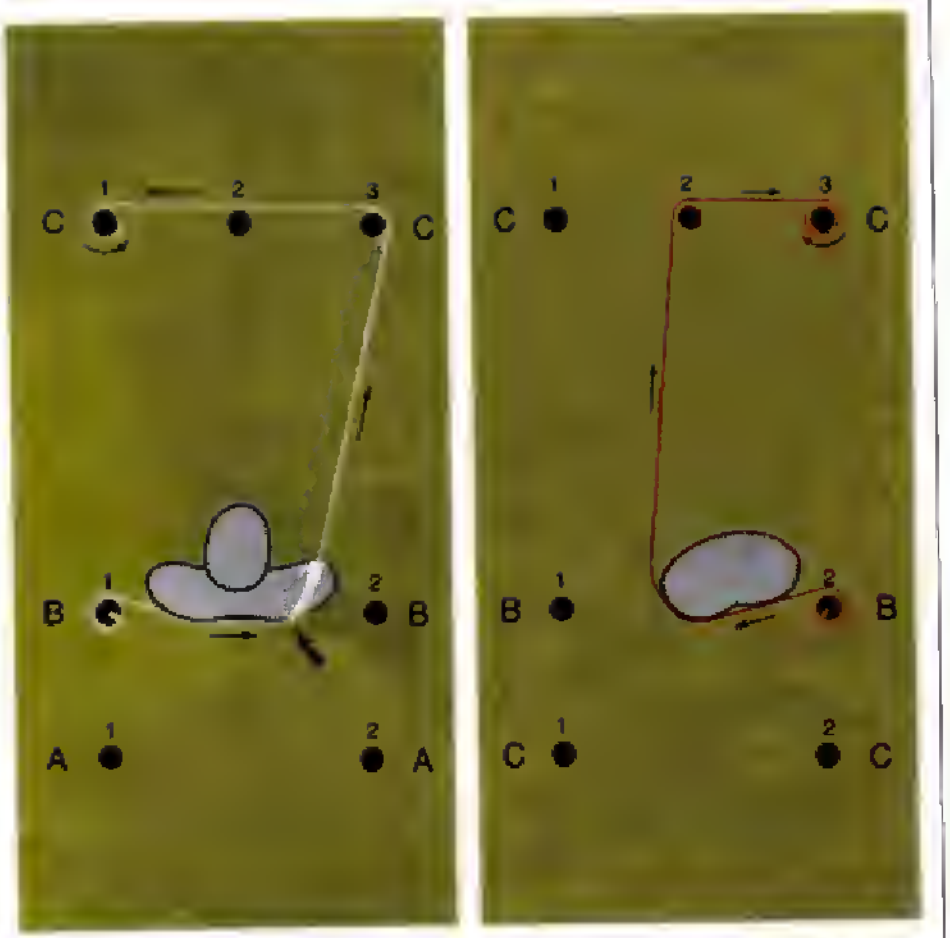

Diagram III: Course of the correction straps for a single-bowed, left-convex lumbar scoliosis or a double-bowed right-convex thoracic/left-convex lumbar scoliosis.

For a single-bowed lumbar curvature a c. 10 cm wide correction strap is passed from the convex side long support horizontally around the trunk to the middle upper support and fixed to the upper lateral support. A counter-proceeding thoracic strap serves to stabilise the trunk (Diagram III, Illus. 90). In the setting of the plaster the pelvis must be restrained on the side of the lumbar correction strap.

IV. Double-bowed, right-convex thoraco / left-convex lumbar curvature.

Number of straps:
2 correction straps.

Course of the correction straps:
The **thoracic strap** passes from B1, horizontally in the direction of the ribs on the convex side, over the rib hump and then laterally and upwards to C3 and across to C1.
The **lumbar strap** passes from B2 horizontally over the loin bulge and then vertically upwards to C2 and C3. (See Diagram III, page 29).

Fixing:
of the thoracic strap, to B1 and C1,
of the lumbar strap, B2 and C3.

Stretching:
rotation of C1 and C3.

Note:
No correction pressure laterally against the thorax flank. Simultaneous stretching of the thoracic and lumbar correction straps and the shoulder strap by rotation of the long supports A1, A2 and C1.


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In double-bowed thoraco-lumbar scolioses we use two contradirectional correction straps (Illus. 88,89, 90). The upper correction strap encloses the rib hump, the lower encloses the loin bulge. Since in this form the shoulder on the convex side is usually only slightly ventrally rotated, and the trunk can be stabilised by the two straps, the additional correction from the shoulder strap is not required.

5. Cutting out the plaster bandage

Pressure points can easily develop at the axillae and groin flexures, and the plaster must be adequately trimmed here, therefore. The EDF plaster is a walking plaster and, though it must fit the pelvis closely, it must be possible for the patient to flex each hip to 90°, otherwise the lower edge of the plaster will press against the thigh. The anterior trunk window is approximately shield-shaped with three rounded angles, the lower angle being about two fingers' breadth above the navel. The posterior window is cut out asymmetrically over the concave side of the thorax (Illus. 91, 92). After this procedure, further correction of the rib hump can be achieved by the insertion of felt padding under the plaster. Cotrel uses a baseball bladder for correction.

6. Shirt change

A change of shirt under the plaster jacket is simple, since there is no collar, but rather a V-neck to negotiate. The shirt change is attained in the following stages (Illus. 91, 92):

1. drawing over the head;
2. drawing of the shirt under the shoulder pieces to the right and left arms;
3. insertion of the right arm;
4. insertion of the left arm;
5. securing of the shirt through the anterior and posterior plaster windows and drawing down. With the help of a smooth rod, the shirts is pushed down between the plaster and the pelvis in front and behind, and it can then be grasped and pulled through.

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7. Surveillance of the ambulant patient in plaster

If the plaster technique has been mastered, a patient may be ambulant in a Cotrel trunk plaster jacket. Advantageous though this is for the patient, in several ways, this should not be at increased risk. Difficulties arising require immediate medical attention, since the occurrence even of single skin lesions can significantly impede the continuity of treatment. Pressure points arise most frequently at the plaster edges, over the spine of the scapula, at the ridge of the rib hump and over the coccyx. These must be inspected immediately and, if necessary, a new plaster applied. The undershirt should be changed daily, it is resistant to boiling and can be washed with the ordinary linen.

Checks of the ambulant patient should be made at three or four week intervals. Experience has shown that the trunk accommodates to the correction plaster in 6 to 8 weeks, and further correction can only be achieved by the application of a new plaster.

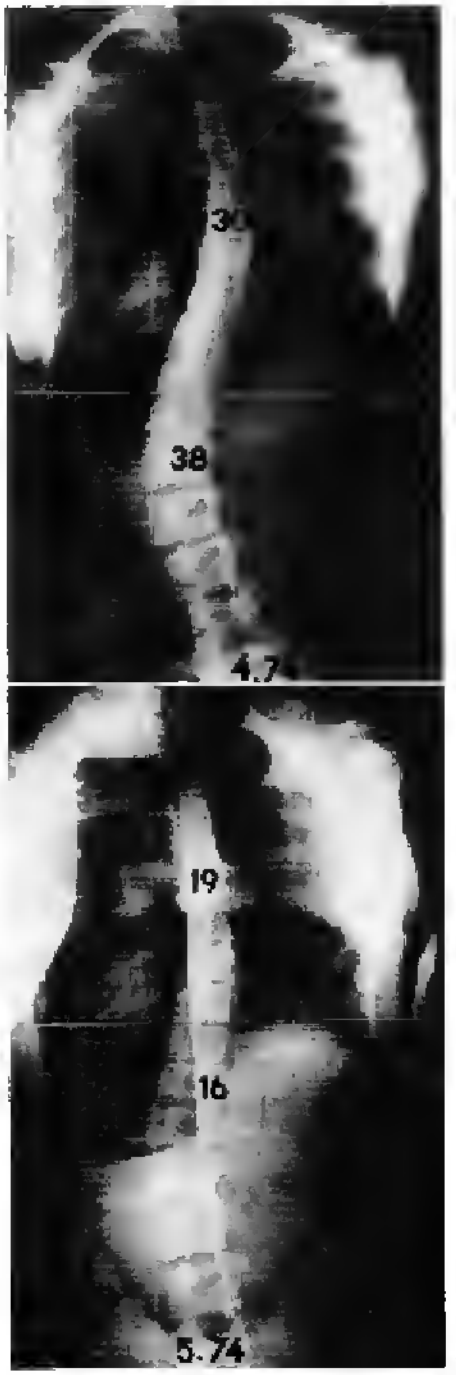
Patients wearing plaster jackets who develop pulmonary infections require careful medical observation and treatment which are only possible by their admission to hospital. If necessary, the plaster must be split and the front half removed, for relief of the chest. The patient lies on the dorsal half which now acts as a resting shell, so as to maintain correction. When the infection has gone a new plaster can be applied.

Indication and duration of treatment

The corrective plaster jacket is an essential element in the conservative and operative treatment of scoliosis. The material costs are low. With a practised team using the plaster slab technique, the plaster can be applied in 30 minutes. The material does not harm the skin; in over 500 cases in recent years we have observed an allergic skin reaction in only one case.

The straightening of a scoliosis and correction of the scoliotic trunk deformity are as impressive as with the spinal corset (Illus. 93, 94). In young patients with scoliosis in the region of indication between conservative and operative therapy, the application of one or two EDF plasters before that of a Milwaukee Corset has been found to be successful. In the plaster the spine is straightened vertically above the pelvis. The waist is moulded so that the fitting of the pelvis presents few difficulties. The corset then takes over the task of holding the correction obtained.

By **alternating treatment** with staged plasters in the winter months and the Milwaukee Corset in the warmer seasons, it is possible, in young children with severe but still flexible scolioses, to arrest the progression of the curvatures and to defer the necessary fusion operation until after the tenth year of life, when conditions for operation are more favourable and the growth loss in the spondylosed section of the spine will be least disadvantageous in relation to body proportion.



93/94

After spinal fusion operations, which we almost invariably combine with the instrumentation developed by Harrington, external plaster immobilisation is necessary for at least one year. Only after the course of this period can it be assumed that the fusion is sufficiently firm and stable to hold the corrected position of the spine against postural and muscular forces. For long fusions of over 12 segments or for loosening of implanted rods, longer times are necessary. Here a supportive corset is recommended for a further 6 to 12 months.

Naturally it is possible to replace the plaster jacket 6 months after operation by a supportive corset which is worn for a further year.

In the postoperative plaster immobilisation phase the plaster jacket is changed by us twice in most cases. The first change of plaster is made relatively early, about 10 to 12 weeks after the operation, in order to obtain further correction of the scoliotic trunk deformity. A second plaster change is necessary about 6 to 8 months after operation. According to the position of the fused segment, in this plaster jacket the collar may be shortened or entirely omitted. The essential support of the trunk is then not at the occiput but rather in the region of the thoracic and abdominal flanks on the convex side.

Using the plaster slab technique the plaster jacket can be kept relatively lightweight. This is an essential prerequisite for the physical activity of the patient. Attendance at school and light physical work are possible in such a plaster. Even sporting activities (table-tennis, cycling with caution) are possible and are permitted by us. A small medical gymnastic exercise programm offers predominantly isometric muscle training.

The preparation of corrective plasters for the straightening of the scoliotic spine and correction of the trunk deformity has attained a certain perfection by the plaster strip technique. Further improvements of this form of treatment are likely only by alterations of the quality of the materials. In this respect continued industrial researches are welcome. The development and preparation of lighter plasters of unaltered strenght and the development of waterproof materials – provided no significant increase in cost is entailed – are desirable in the interests of the patient.

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